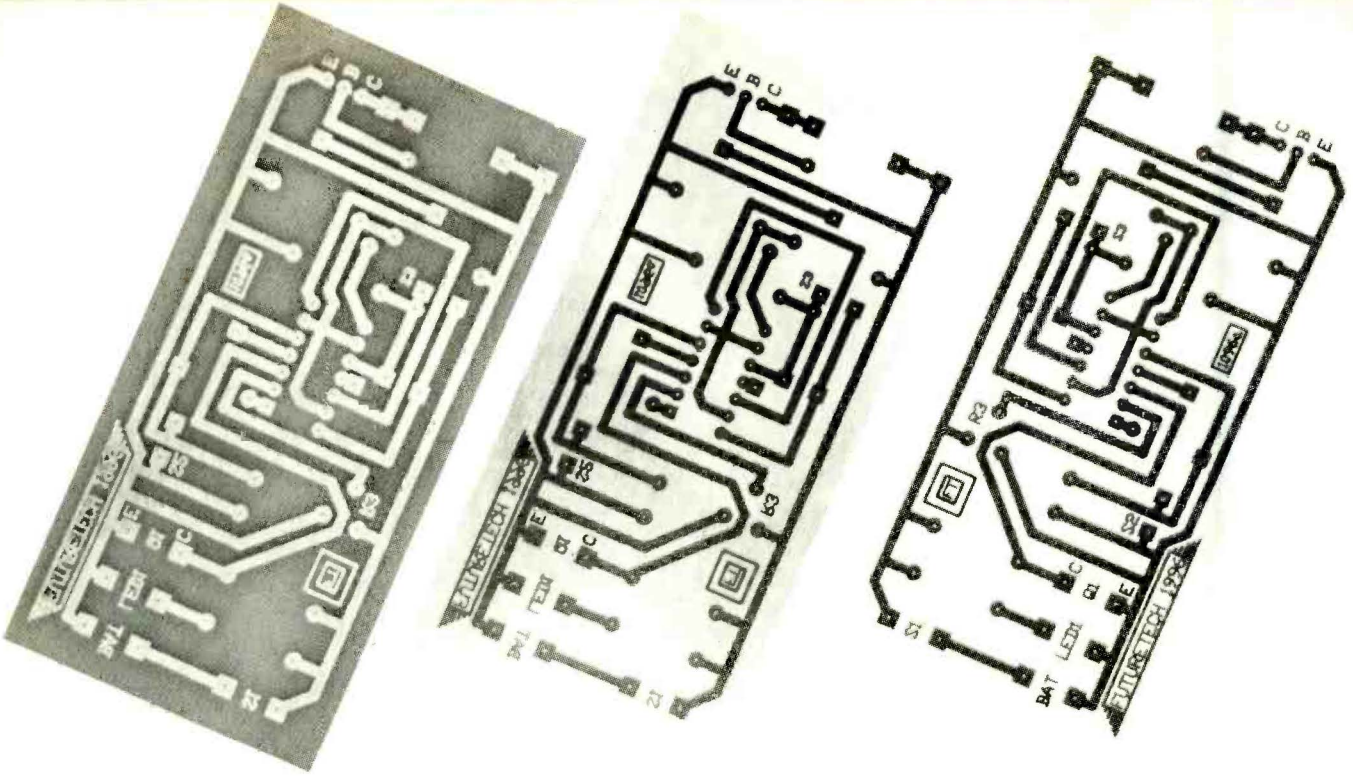

MAKE YOUR OWN PC BOARDS USING TONER-TRANSFER PRODUCTS

Once you've learned how, there's no easier way to make PC boards, especially if you need more than one.

LARRY BALL

What's the easiest way to make ten or twenty identical printed circuit boards? Well, while there's many different techniques you could use, in my experience toner-transfer products are your best bet!

Now, perhaps you've heard that they don't work very well, or that they're a hassle to use. Well, the truth is that toner-transfer products (which we'll refer to as TTPs) require time and effort to learn to use properly, but once that effort is expended, they'll save you an enormous amount of work, time, and money.

For the balance of this article, we'll show you how to use TTPs, and help you decide which TTP is best for your needs. We'll look at DynaArt's Toner Transfer System, Techniks' Press-n-Peel (both blue and wet versions), and Meadowlake's TEC-200 Image Film; explore the similarities and differences of those products; and most importantly, compare the results you can obtain with each. We'll also cover tips to save you money when using TTPs, and help you get better results.

TTPs fall into two broad categories: transparencies and coated papers. Transparencies are ironed on and carefully peeled off, while coated papers are ironed on and soaked to remove the TTP. However, aside from that difference, the steps and procedures followed when using all TTPs, which are described below, are pretty similar. The PCB artwork is usually created using a computer program. The artwork is transferred to the TTP with a laser printer (although it can be transferred using a copying machine, as in the case of magazine artwork). The artwork is then ironed onto an extremely clean printed-circuit board (PCB), the TTP is removed and the PCB (which now has the artwork on it) is etched to remove unwanted copper. Let's take a closer look at how each step is done.

Creating the Artwork. Unless you're using artwork from a magazine article or the like, you'll have to create your own using a PCB drawing program. If you are already familiar with those programs, you know what's involved and how easy it can be. Unfortunately, space prevents us from going into those programs in any great detail. However, the good news is that the January 1996 issue of **Electronics Now** features an excellent article on the subject. It is a great introduction to the topic and features discussions of some of the most popular packages on the market.

Transferring the Artwork to the TTP. Once the artwork has been created, it must be transferred to the TTP. Whether you're using a laser printer or copying machine, be sure to print your artwork on ordinary

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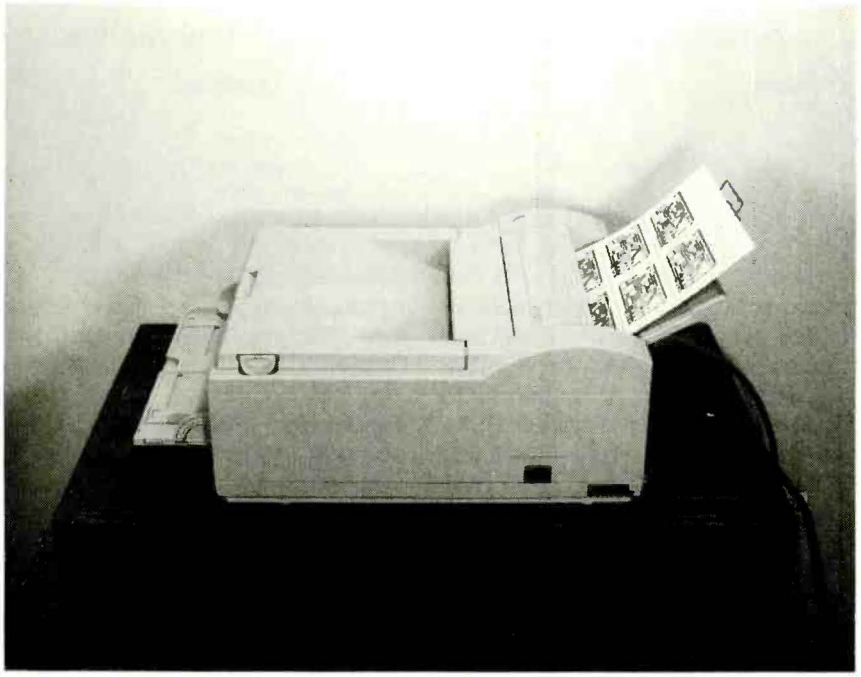
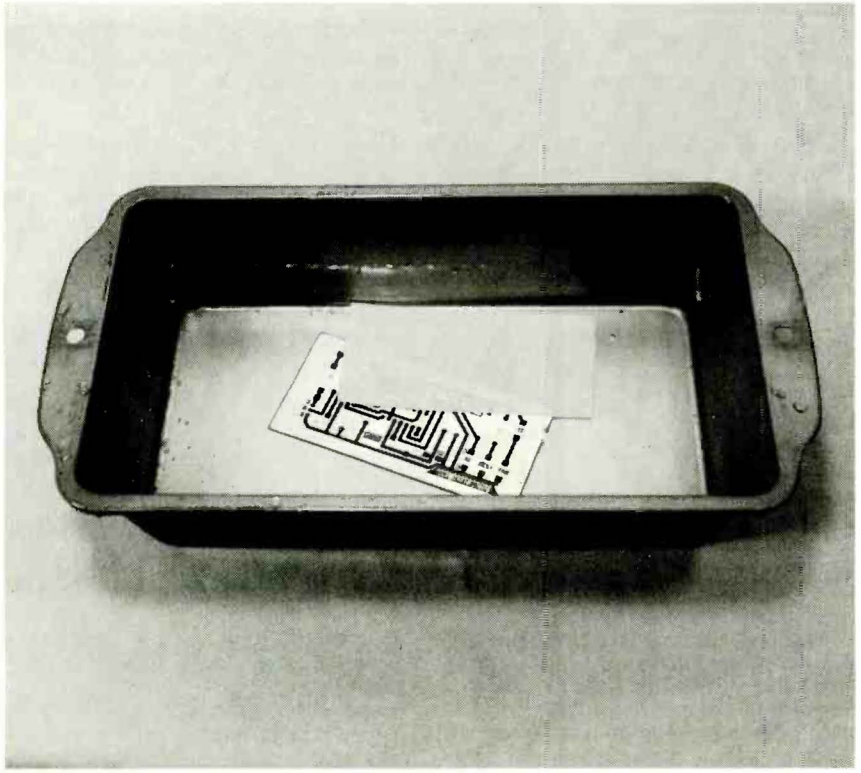


After you create the PC-board pattern using any PCB drawing program, it is output on a standard laser printer. Use the printer's darkest setting and select the straightest possible paper path. Place multiple images on a single sheet to conserve the toner-transfer media.

paper to check its orientation and quality. It's better to waste a sheet of copy paper than a sheet of TTP.

Large copying machines work better than small ones. For example, DynaArt recommends Xerox 10xx, 50xx series, and Kodak three-digit model-number machines. Since the toner will become the actual etch resist, all copying machines and laser printers should be set to their darkest settings.



After ironing, paper-based TTPs are soaked in water to remove the paper from the PCB. Be patient as peeling the paper before it has soaked off could produce poor results.

Avoid getting fingerprints or dust on the TTP since they degrade its performance.

Once the artwork is transferred, the TTP can be carefully stored for later use.

Preparing the PCB. A properly prepared PCB can make the difference between a good toner transfer, or a frustrating, wasted effort. After you de-burr the board's edges, it has to be thoroughly cleaned. There are expensive chemicals that will do the job, such as London Chemical's Loncoterge, but the usual solution is to scrub the board with an abrasive cleaner (like Comet) until it's completely spotless, turns a hot pink color, and water forms sheets on it. Never forget that the end product of the transfer is directly related to how clean the board is!

Next, to improve adhesion, rough up the surface with Scotch-Brite, steel wool, or 400-to 600- grit wet/dry sandpaper. In my experience, regardless of which TTP is used, 400-grit sandpaper seems to work best.

Once that is done, rinse the board with rubbing alcohol and dry it with a paper towel or blow dryer. Allowing it to air dry usually results in tarnish on the PCB.

Transferring the Artwork to the PCB. TTP manufacturers suggest several methods of transferring the artwork from the TTP to the PCB. The most common method is to place the PCB on a flat, heat-resistant surface, with the TTP on top of it, and the iron on top of the TTP; and then to apply moderate pressure for a specified time at a specified temperature. The times and temperatures specified by the manufacturers are provided in Table 1.

There's an alternate method that is useful for large PCBs and/or paper-based TTPs: Place several pieces of thin cloth on a flat surface, the TTP on the cloth, the PCB on the TTP, and the iron on top of this stack. Slightly more time is needed when using this "upside-down" method.

Still another method for small boards is recommended by the makers of TEC-200. They suggest

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heating the PCB itself, and then placing the TTP on top of the heated board and using a small rubber print roller to apply the TTP.

Since different toners melt at different temperatures, you'll have to experiment to find the time and temperature that works best with your toner and system. Generally, it's okay to use more time (up to several minutes more). The times, temperatures, and techniques that have worked well for the author are given in Table 2.

What about motion? Well, when heating the PCB and TTP with the iron, Techniks suggests that you concentrate on getting one corner to adhere, and then apply the heat using a circular motion, especially towards the outer edges. Usually, just moving the iron every 30 seconds will provide even heat and pressure.

Once the artwork is ironed on, transparency-based TTPs are cooled and then carefully peeled backwards 180 degrees. Paper-based TTPs are carefully placed in water to soak the TTP. The TTP will peel off on its own in a few minutes (avoid the temptation to help it!). In either case, the PCB will usually need to have the transferred artwork touched up with an etch-resist pen. Inspect the PCB with a magnifier to see if you've missed any tiny holes or cracks in the traces. If you consistently get more than a couple of "drop outs" in your traces, you'll need to adjust your time, temperature, pressure, PCB cleanliness, or technique.

The PCB is now ready to etch, and should be etched immediately for best results. Waiting will allow the PCB to tarnish, and may result in a poorer final product.

Product Comparisons. An article like this one would be incomplete without some more in-depth discussion of the various products and the results obtained with each, as well as some product-specific hints and techniques that the author has found helpful. For these comparisons, note that all printing was done with a new OKIDATA OL600e laser printer using an OEM toner-and-drum cartridge. The printer was set on its darkest setting. The manual paper feed and auxiliary paper exit were used to provide a paper path with the least number of bends. Toner was transferred to over 60 identically cleaned PCBs, and over 20 were etched. Sizes varied from 4 by 5 inches to 1½ by 2 inches. The benchmark was 2 by 4 inches. As expected, it was found that TTPs are easier to use with smaller PCBs.

TABLE—1
MANUFACTURER'S RECOMMENDED TIMES AND TEMPERATURES

Product	Time	Temperature
TEC-200	not specified	265-295 degrees F; "wool" setting
DynaArt	2-3 minutes	300-350 degrees F (possibly more); "cotton" setting
Techniks PNP (Wet and Blue)	45-100 seconds	200-225 degrees F or higher; "steam" setting

Techniks' PNP WET. In the author's opinion, PNP WET is the most forgiving TTP tested. It works well over a wider range of temper-

TTP TIPS

If the artwork doesn't transfer completely, the most likely causes are: not enough time, PCB not clean enough, temperature too low, or uneven heat and/or pressure.

If the edges of your artwork appear "squashed" on the PCB, you probably used too much pressure.

Don't leave the iron in one place more than 30 seconds even when transferring the TTP to a PCB smaller than the iron. It needs to be moved to provide even heat and pressure.

When ironing a transparency, you can usually tell when it's ready by looking for the pattern to become more apparent.

All copying machines and laser printers should be set on their darkest settings!

Whether you're using a laser printer or a copying machine, be sure to print your PCB on ordinary paper first to check its orientation and quality.

Allow your iron to heat up for several minutes to give a consistent temperature.

Here's a method that is useful for large PCBs and/or paper-based TTPs. Place four pieces of thin cloth on a flat surface, the TTP on the cloth, the PCB on the TTP, and the iron on top of this stack. Slightly more time is needed to use that "upside-down" method.

When printing on TTPs with a copier or a printer, use the paper path with the least number of bends.

Paper-based TTPs can be sprayed with lacquer after printing, and then soaked to obtain a see-through sheet of artwork useful for making faceplates and decals.

DynaArt suggests replacing your drum with an "acrylic" high-capacity drum and your toner with high-density "graphics" toner. They sell those products, as well as a "super fuser" to replace the iron in the toner-transfer process.

To save money on their TTP, DynaArt also suggests cutting it into pieces slightly larger than your PCB artwork, and taping the pieces on a sheet of copy paper (with a paper-type tape, and on the leading edge only), and then sending the copy paper/TTP combination through the printer. If your printer won't pass two sheets of paper taped together, you'll need to cut an appropriate hole in the copy paper.

Another idea for getting the most out of your TTPs is to put multiple images on a single page.

When drawing your PCB artwork, remember that larger traces and pads are more forgiving in the toner transfer process.

Etching your PCBs in a heated bubbling tank will save you an enormous amount of work; the December 1989 issue of **Radio Electronics** has an excellent article on one you could build yourself.

Gaps in traces on finished PCBs may be repaired with a Circuit Works conductive pen.

Techniks (PNP WET/BLUE) recommends that the image transfer sheet be cut leaving at least ¼-inch around the circuit pattern.

Leave no more than a ½-inch border of clear film around the pattern, when using TEC-200 Image Film, to avoid distortion in the transferred artwork.

TEC-200 Image Film could be used to create a mirror image of your artwork, when used in a copier. For best results, a clean white sheet of paper should be placed on top of the film being copied. The film used to make the intermediate copy can then be cleaned with an organic solvent and reused.

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NAMES AND ADDRESSES

Product	Price and Suppliers
DynaArt Toner Transfer System (paper-based product)	5 sheets/$15.00 DynaArt Designs 3535 Stillmeadow Lane Lancaster, CA 93536 Tel: 805 943-4746
Techniks Inc. Press and Peel (BLUE is transparency based) (WET is paper-based product)	20 sheets/$30.00 Techniks Inc. P.O. Box 463 Ringoes, NJ 08551 Tel: 908 788-8249
TEC-200 (transparency-based product)	5 sheets/$3.95 DC Electronics P.O. Box 3203 Scottsdale, AZ 85271 Tel: 800 467-7736
Loncoterge (copper cleaner) Part #CU3-1QT	$17.75/quart Kepro Circuit-Systems 630 Axminister Drive Fenton, Missouri 63026 Tel: 800 325-3878

Note: Single sheet quantities of toner-transfer products are available from Futuretech (P.O. Box 6291, Gulf Breeze FL 32561, Tel: 904 932-9682): DynaArt Designs $3.50/sheet, Techniks Press and Peel (both WET and BLUE) $2.00/sheet, Meadowlake TEC-200 $1.15/sheet. Sample pack of one each of all four toner transfer products $8.50/pack. Add $3.00 for shipping and handling. Florida residents add 7% sales tax.

atures, times, and pressures. It usually applies cleanly with very few "drop outs." The end result (etched PCB) is among the best tested. This TTP works well when applied using the "upside-down" method with four thin sheets of cloth placed underneath it.

Techniks' PNP BLUE. PNP BLUE is different than other TTPs in that it transfers a coating in addition to the toner. The coating/toner combination sticks extremely well to the PCB and provides extra protection during etching.

On the down side, you have to be very careful to use a light pressure and correct temperature, or you'll lose fine detail in your traces. Furthermore, the coating is so thick that you have to be more careful while touching up any "drop outs" as the etch-resist pen must fill in both the "drop out" and the transition between the thickness of the coating and the PCB. Fortunately, this technique usually requires very little touching up.

The durability of the extra coating makes it one of the most reliable TTPs tested. To get the best results, this product should be applied using the right-side-up method with a thin sheet of cloth between it and the iron.

TABLE 2—AUTHOR'S SETTINGS

Product	Time	Conditions
TEC-200	3½ minutes	250 degrees "permanent-press" setting light pressure
DynaArt	4½ minutes	410 degrees "linen-high" setting heavy pressure
Techniks PNP WET	4 minutes	310 degrees "wool-cotton" setting upside down method
Techniks PNP BLUE	3 minutes	275 degrees "wool" setting light pressure

Meadowlake's TEC-200. With TEC-200, it is easy to consistently get clean, sharp transfers. However, the clean, sharp image can be deceiving. When using TEC-200, you'll need to strike a balance between a higher temperature (which will give the best adhesion), and a lower temperature (which will give you the darkest, most solid traces). Also, avoid excessive pressure, which will make the traces squash internally and become "see-through." "See-through" traces will result in tiny holes in your etched PCB's.

Once you've found the proper temperature and pressure, this product will give you easy, consistent results. It's best applied using the right-side-up method with one thin sheet of cloth between it and the iron.

DynaArt's Toner Transfer System. DynaArt's Toner Transfer System can give you sharp PCB images with few "drop outs," but it won't tolerate inconsistent or sloppy application techniques. To get consistent results, your time, temperature, and pressure must be very consistent. It also requires more pressure than other TTPs. Unless you're transferring your artwork to a PCB larger than your iron, the right-side-up method is best for this product.

Conclusion. The good news is that all the TTPs tested will do the job. The bad news is that even with the ones that are easiest to use, you'll need to do some trial and error experimentation to get the correct combination of time, temperature, and pressure for your printer's toner, and to get a feel for using the product. Even then, one or two small "drop outs" per PCB are to be expected.

TTPs require effort on the part of the user. But once you learn the best methods, TTPs will save you loads of time, money, and effort. To help reduce the learning curve a bit, many of the points addressed in this article, as well as a few additional ones, are summarized in the box titled "TTP Tips." Ω

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